Analysis of Samples for Bulk Chemistry
Obtained during the GLOBE flight series

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Edward M Patterson
School of Earth and Atmospheric Sciences
Georgia Institute of Technology
Atlanta, Ga 30332-0320

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Introduction

This report presents the results of the analysis of a portion of the bulk samples for chemistry that were determined as part of the GLOBE flight series. In this report we are presenting the results of the ion chromatography analysis for the second series of flights. A limited analysis of the bulk samples was accomplished; other measurements were made with a nephelometer operating at viisble wavelengths. Some of this data has been presented earlier. Some comparisons between the chemistry data and the scattering data will be presented in this report.

A more complete description of the procedures and the data will be made available to the GLOBE data base.

Sampling and Analysis Procedures

The sample collection procedures have been described in earlier reports. The goal of the sampling was the collection of a sample at the highest flow rate possible consistent with the maintenance of effective sampling geometry with filters having acceptable analytic characteristics. One of the major feature of the sampling process was the achieving of very high flow rates in the cascade impactor. This was due to a combination of a low resistance sampling line, high efficiency pump, and additional pressure differential due to the stagnation air pressure increase in the sampling line forward of the filter. Modifications were made in the system between the first and the second flights to increase the flow through the system by roughly a factor of four. This had the advantage of more efficient sampling as well as a collection of as large a portion as possible of the sample on the low background cascade impactor subtrates rather than the higher background backup filters.

The analysis was carried out using a Dionex ion chromatograph. Analysis was done for both anions and cations, including sulfate, nitrate, and chloride anions and ammonium, potassium, and sodium cations. The measurements were calibrated in terms of multiple secondary standards, and blank substrates were interspersed with the samples.

Two different types of substrates were used, a metal foil substrate for the cascade impactor stages and a high purity quartz fiber filter for the backup filter. The blank values for the sulfate were below detection levels for the cascade impactor substrates, with a detection level of less than 0.5 µg per impactor substrate. Blank values for the backup filters were considerably higher, of the order of 18 µg per filter with a detection level that is determined by the variation in the blank values. The minimum detection level was estimated to be 6 µg/filter. Consequently, the backup filter values are considerably more uncertain than the cascade impactor substrate values.

Results

The list of the samples that have been analyzed is shown in Table 1. The results of the ion chromatography analysis for the sulfate samples for the flights that have been analyzed are

shown in Tables 2 through 6. The chemical composition measurements can best be described as partially successful due to the short sampling times that were possible with each of the samples. Although values that were above background levels were obtained on many of the samples, there appears to be some inconsistancy in the overall concentration numbers for the different stage values for each of the flights. Work is continuing to better understand these results.

One of the goals of the set of measurements was the determination of wheter ammonium was present in the different samples. The ammonimum data are variable, but for Flights 10 and 13, it does appear that ammonium is present in sample 2 of flight 10 and in samples 3 and 4 of flight 13. The ammonium is present in amounts consistent with the presence of ammonium sulfate in the sample. Ammonium sulfate does not appear to be present in significant quantities in the other samples from these two flight days.

A nephelometer comparison was made with sample S4 of flight 10. The nephelometer gave good data at approximately 1.1×10^{-7} m^{-1}. The inferred mass concentration is approximately 200 ng/m^3. This indicates a B_e value of roughly 0.5 m^2/g, suggesting that the values of mass concentration may be somewhat high. as described above, we have considerably more confidence in the cascade impactor stage concentrations than in the backup filter concentrations.

Table 1

Flight Number	Sample	Time on/off	Sample Flow	Altitude
900205	S1	19:34-21:36	328	1000
	S2	22:01-22:56	178	10000
	S3	23:03-23:44	112	20000
	S4	23:50-00:35	132	30000
	S5	00:45-01;22	89	40000
900207	S1	21:41-22:23	100	26000
	S2	23:36-01:10	173	35000
	S3	01:12-02:23	156	35000
	S4	03:00-03:15	50	
900209	S1	02:05-02:40	102	35000
	S2	02:58-03:35	113	26000
	S3	03:37-03:51	33	15000
	S4	03:57-04:10	42	35000
	S5	04:19-04:36	54	35000
	S6	04:55-05:21	77	35000
900210	S1	01:05-02:24	254	26000
	S2	02:36-04:07	303	26000
	S3	04:18-05:32	246	26000
	S4	06:50-07:15	66	26000
900213	S1	01:59-02:34	122	31000
	S2	02:43-03:50	178	35000
	S3	04:18-04:55	109	20000
	S4	05:11-05:38	71	10000
	S5	06:13-07:11	178	26000

Table 2

Flight 5 Sulfate Data

Concentration ng/m^3

Stage/Backup	3	4	5	BU	
S2	48	n	10	b	
S3	n	14	16	b	
S4	n	b	18	50	
S5	n	n	13	91	

b--below detection limit
n--stage not used for sample
s--problem with sample

Table 3

Flight 7   Sulfate Data

Concentration ng/m^3

Stage/Backup	3	4	5	BU
S1	8	n	4	b
S2	n	2	3	b
S3	3	n	5	b
S4	n	b	10	b

b--below detection limit
n--stage not used for sample
s--problem with sample

Table 4

Flight 9 Sulfate Data

Concentration ng/m^3

Stage/Backup	3	4	5	BU
S1	n	n	12	104
S2	n	n	11	159
S3	n	n	b	b
S4	n	n	28	b
S5	n	n	b	268
S6	n	n	23	155

b--below detection limit
s--stage not used for sample
n--problem with sample

Table 5

Flight 10 Sulfate Data

Concentration ng/m^3

Stage/Backup	3	4	5	BU	
S1	9	n	41	47	
S2	2	n	10	43	
S3	5	n	5	39	
S4	n	n	18	200	

b--below detection limit
s--stage not used for sample
n--problem with sample

Table 6

Flight 13 Sulfate Data

Concentration ng/m^3

Stage/Backup	3	4	5	BU
S1	b	n	5	b
S2	n	n	3	b
S3	11	n	43	87
S4	n	74	99	s
S5	5	n	10	b

b--below detection limit
s--stage not used for sample
n--problem with sample